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BULLETIN

—OF THE—

CHICAGO ACADEMY OF SCIENCES.

A PAPER ON

The Northern Pitcher-Plant or the Side-saddle Flower,
Sarracenia purpurea, L.

By W. K. HIGLEY.

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The Northern Pitcher Plant or the Side-saddle Flower, Sarracenia purpurea, L.

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That insects are of great use in the vegetable economy is a subject of much interest to many scientific minds of the present day, causing many investigations resulting in experiments that are leading us into a deeper and truer knowledge of the physiology of plants.

These investigations are transforming many theories into facts; many mere fancies into realities; many of the so-called "freaks of nature," of the older writers, into useful adaptations for aiding in the development of the plant. It is now obvious, even to the slack and unscientific observer of nature's laws and methods of work, that the insect world is necessary for the proper growth and propagation of many species belonging to the vegetable kingdom.

It is well known to the intelligent agriculturist that many of the plants used in our economy could not even mature their seeds unless aided by insects, notably the hive bees. The beautiful orchid family is a grand illustration of the usefulness of insects in fertilization. Dr. Charles Darwin has shown that each part of the flower is adapted to this end. It seems as if, in this family, nature truly abhors self-fertilization and in some species, though giving the plant all the parts of a hermaphrodite, yet arranging them so that only an insect can bring about the proper relations for propagation. Our melon, pumpkin, squash, cucumber and gourd plants are also worthy of note in this connection. "The flowers" of these "are each furnished with a long or rather deep corolla and the plants often lie flat on the ground where the leaves cover the flowers from the action of the wind. Bees and other insects are the necessary agents in crossing the flowers", for they are either diœcious or monœcious, "and to them we are indebted as one of the links in the chain which affords all our gourd-like fruits."

To this division of Entomophilous species belongs the plant under consideration in this paper. All the species of the genus Sarracenia are constructed in such a manner that in fertilization they are absolutely helpless without the aid

of insects. The large umbrella-like expansion of the style, which is stigmatic at the termination of the fire rays, completely hides the stamens which are decidedly below it and shielded from the wind.

A still more peculiar use of insects to the vegetable world is that of a food and many plants are specially fitted for catching and useing the material of their bodies for nourishment.

Perhaps the most striking of all these plants are the pitcher-plants, some of which throw out a honeyed secretion which, trickling down the wing of the pitcher, forms a baited pathway to attract the unwary insect to the inside of the pitcher.

The genus Sarracenia, to which the plant under consideration belongs, is one of the three genera of the order Sarraceniaceæ. The species of all the genera are natives of America and chiefly of the United States, the genus Heliamphora being a native of Venezuela. Mr. Sereno Watson * makes the following enumeration of the species of the other two genera, Darlingtonia and Sarracenia:

Darlingtonia Californica, Torr.
Sarracenia Drummondii.
" flava, L.
" psittacina, Mx.
" purpurea, L.
" nigra, Walt.
" Sweetii, D C.
" undulata, Denie.
" variolaris, Mx.

All the species have root-leaves and excepting the genus Heliamphora, have terminal scapes bearing a single flower. The exception has a scape bearing a few flowered raceme. The leaves are all hollow and more or less pitcher-shaped, with a hood at the upper part and a wing, that is often very broad, upon one side.

As to their position in classification, this family† quite closely resembles the poppy family (Papaveraceæ,) on the one hand, and the water-lily family (Nymphæaceæ) on the other. It is related to the former by the character of its petals, numerous stamens and seeds, capsular fruit, copious albumen, etc. It is connected with the latter by nearly the same characters,‡ and also by having all the leaves from the root, a one-flowered scape and more or less aquatic habits. The poppy family differs in habits, juices, in having but two or three sepals and a one-celled ovary. The water-lily family differs in having, usually, numerous petals, in the attachment of the seeds and the sessil stigmas.

By certain analogies the pitcher-plants are closely related to the sundew family (Droseraceæ), and the Asiatic pitcher-plant family (Nepenthaceæ).

A microscopical study of the minute structure of the families mentioned not only confirms the close relationship existing between them but also adds new facts to those that appear from a study merely of the external characters of their representative species.§

*Bibliographical Index to North America Botany, by Sereno Watson, Smithsonian Miscellaneous collections.

†General System of Botany, LeMaout, and Decaisne. p. 212.

‡The water-lily family in some of its forms has a definite number of stamens.

§Since the writing of this paper Mr. J. F. James has published a very interesting article on "How the Pitcher Plant got its Leaves." (American Naturalist Vol. xiv, p. 567.)

After tracing the apparent gradation of adaptability for taking insect food existing beween the species of the genera of Sarraceniaceæ from the less marked trap and imperfect

Our northern pitcher-plant is, perhaps, the one of greatest interest to the people of the Northern States.

It is by far the most common form of the genus extending in its range over the states east of the Mississippi and north from Florida far into the British Possessions. It is not so elaborate an insect catcher as some of the more southern forms which have already been spoken of as throwing out a honeyed lure which attracts numerous ants, an insect rarely found in our species.

The pitcher leaves (Ascidia) of the Side-saddle flower, as well as those of all the family, are evidently phyllodia. They have the parallel veination of petioles acting as blades and the edge is invaribly turned toward the sky. The hood may represent the blade of the leaf. The wing forms the greater part of the young leaf.

Inside these pitchers are found hairs, which cover more or less of the inner surface. Those which cover the hood continue to or a little beyond the junction with the tube. Following this area is a smooth surface which extends to near the point where the leaf begins to contract when a patch of less stiff hairs are met with. This time they extend into the narrower portion of the tube. All the hairs point downward.

The position and form of these hairs, especially those on the hood and upper part of the tube and in fact any that may be above the fluid, in the lower part of the leaf, would show that their function, in part at least, is to prevent the escape of any insect that may have entered the tube. The hairs in the lower part of the tube probably act, to some extent, as absorbents of the nitrogeneous matter decaying within the leaf. Some acute observers claim that at the end of each hair there is a minute opening, thus allowing the nitrogeneous fluid to pass directly into the apical cell of the hair. This does not seem to be the case but instead the wall surrounding the entire cell is very thin. These hairs are simple trichomes, that is they are rather cells than organs. Unlike the tentacles of the sundew, in no case do the spiral bundles enter their tissue. I am inclined to believe that these cellular hairs serve more than one purpose in the economy of the plant.

A study of the structure and physiology of the whole family shows that all the forms need a great deal of absorbing surface for there seems to be a lack of stomata. The tissue of the leaf is almost constantly gorged with a large supply of nourishment consisting, evidently, of absorbed nitrogeneous matter, and

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pitcher of Heliamphora through the genus Sarracenia to the remarkable trap pitcher of Darlingtonia with its attractive appendages, digestive fluid and sweet lure, Mr. James says: "Scarcely any of the steps showing the progress are needed to complete the line of development. It can be traced directly from Heliamphora to Darlingtonia, and it is only necessary to have an ancestral form from which to start to have a complete pedigree. It seems probable that the water-lily family and the pitcher-plant family had a single ancestor in common. This ancestor was aquatic, or least an inhabitant of swampy places. It had small, probably peltate, perhaps reniform leaves, and these had hollow petioles. The inner space was lined with hairs as are now the inner surfaces of the stems of Nymphæa and its allies; it had a four or five parted flower, with many stamens and a broad stigma. From such an ancestor came two or three branches. One of these developed into plants having an aquatic habit, large leaves and long petioles, and peduncles like those which are found at present in the water-lilies. The other branch diverged to form plants living in boggy or swampy grounds, with pitcher-like leaves whose insectivorous proclivities were developed later on."

Mr. James suggests that these proclivities were developed by a true process of natural selection. The more or less saucer-like peltate leaves may possibly have held some water in which insects were drowned. This fluid, by standing causing the decay of the blade at the insertion of the petiole, found its way into the hollow petiole and finally by absorption of the nitrogenous matter the plants gained nourishment that could be used in its growth. This adaptation being of use to the plant might lead, in the next generation, to leaves better fitted for taking food in this manner. This in course of time would give rise to a generation of petioles peculiarly adapted to catching water and insects by being pitcher-like in form. The blade no longer needed for absorption would become a mere rudiment and then would follow the further process of perfecting traced by Mr. James in Sarraceniaceæ.

needs a great extent of surface exposed to the air for the purpose of absorption in carrying on the functions of assimilation and metastasis. In support of this there is considerable evidence, the most important of which is the fact that many of these hairs, especially those on the hood, contain chlorophyl. From a study of marked leaves through the whole season I am led to believe that some of the hairs are absorbed as the leaf grows old. This would indicate that as the function of the leaf are lessened the extent of absorbing surface is reduced.

When the leaf has apparently nearly stopped absorbing the moisture from the tube it may still be an active insect trap. At this time an especially strong odor is given off from the decaying mass of insects. It would seem that the insects caught now could be of no use except as a fertilizer, when by the decay of the leaves, all this mass of decomposing nitrogeneous matter is deposited around the roots of the plant. The decaying material, moreover, seems to hasten the decay of the leaf, as its vitality is lessened by the advancing season.

It is noticeable that there are many insects around the leaves just at twilight or when the sky is overcast with heavy clouds. Remains of nocturnal insects are also very common in the mascerating mass. This seems to indicate that flies and other insects seek the hollow leaves in which to retreat during the hours when they are naturally at rest. It is a fact that insects seek retreats of this kind.

True to the habits of the spiders to seek those places for their homes that flies frequent, there is one that makes its home at the top of the leaves spinning its web so that it nearly covers the whole opening. In each case that I have observed it is the same species but whether it always seeks the pitchers, I cannot state.

An insect lighting upon the leaf starts immediately to walk toward the inside. It seldom stops till the smooth place is reached where sooner or later it loses its foot-hold and falls. In some cases they try to fly upward from the bottom of the pitchers. In but one case have I seen an insect escape in this manner. This, a beetle, obtained its freedom by flying from one side of the tube to the other till the opening was reached.

A slight secretion has been observed by many near the opening of the pitcher. This seemingly has but little power to attract insects, though at times it is quite copious.

Mr. Joseph Jackson says,* "While collecting a few specimens of S. purpurea, L., I was surprised on drawing aside the petals to look at the stamens to see the whole cavity formed by the petals and the peltate expansion of the style filled with flies as large as the common house fly, all busy as could be eating the pollen, of which scarcely a grain could be seen. I counted fourteen flies in one flower. They were in no hurry to vacate the premises. There was a shower coming up at the time, but they were evidently there for food. Nearly every plant examined was filled in the same way."

Mr. J. F. James suggests† that perhaps "there is something in the pollen, or in some secretion of the flower which has the effect of stupefying or intoxicating the insect and that then they might easily be shaken from the flower, by the wind, into the open mouths of the rosette of leaves below."

My observations differ somewhat as to the usefulness of these insect visits to the flowers. There are two or three species of Diptera found in the manner described. They are evidently attracted to the flower by some property of the

*Bot. Gazette Vol. VI. No. 7.

†Amer. Nat. Vol. XVII, p. 284.

pollen or a secretion of some other part of the flower, but it would seem mainly for the purpose of aiding in fertilization for a lense reveals the fact that pollen is quite freely scattered over their backs. Moreover, these plants flower during the latter part of May and first of June, while insects are caught during the months of May, June, July and August. Though without question some of the flies from the flowers do eventually find their way into the pitchers underneath, yet these species are not nearly so common in the decomposing mass as some other species. Some time was spent in taking notes as to the effects of this food upon the flies but without any results showing stupefaction.

The great question is: What purpose do the decaying remains in the bottom of the tube serve in the economy of the plant? In order to decide this question it will be necessary to know the chemical nature of the fluid found in the pitchers. Several chemical analyses were made under as widely different conditions as a limited region of country would allow. As a result of the examination of over 800 leaves I find that none contained any fluid before they had opened. These were collected from several localities. After opening there is no fluid till after the first rain except in a few cases when there has been a heavy dew.

The following table is the result of a series of twenty-five chemical analyses, selected from one hundred the total number made, and shows approximately the composition of the fluid before it contained any insects. The sediment is the result of evaporation:

Number.	Condition of the Soil.	Time in days since leaf opened.*	Time in days since rain had fallen.	Color of Fluid.	Dri'd Residue from Evaporation† Organic.‖	Dri'd Residue from Evaporation† Inorganic	Reaction.	INORGANIC SUBSTANCES.	REMARKS.
1	Swamp	5	1	Clear...	3...	2....	Slightly acid	Ammonium, ‡Potassium, Carbonic Acid...............	
2	Swamp	8	4	Slightly Yellow..	9...	3....	Acid....	Ammonium, Lime, Potassium, Carbonic Acid.........	Under trees in edge of swamp.
3	Swamp	15	3	Yellow..	11...	4....	Acid....	Ammonium, Potassium, Sodium, Hydrochloric, Sulphuric and Carbonic Acids.	Under trees in edge of swamp.
4	Dry	20	18	Clear...	14...	5....	Acid....	Ammonium, Potassium, Lime, Sodium, Magnesium, Carbonic, Hydrochloric, and Sulphuric Acids.	At edge of woods in soil containing much lime.
5	Moist	6	2	Clear...	6...	3....	Acid....	Ammonium, Lime, Potassium, Hydrochloric and Carbonic Acids.	Not far from the last.
6	Wet	10	4	Tinged..	8...	3....	Acid....	Ammonium, Potassium, Sodium, Sulphuric, Hydrochloric and Carbonic Acids.	
7	Wet	12	8	Tinged..	10...	4....	Acid....	Ammonium, Potassium, Lime, Aluminium, Sulphuric and Carbonic Acids.	Near dusty road and under trees.
8	Swamp	15	14	Tinged.	20...	5....	Acid....	Ammonium, Potassium, Lime, Aluminium, Iron, Sulphuric and Carbonic Acids.	In neighborhood of several iron springs, near a road and under trees.
9	Swamp	11	5	Yellow..	7...	3....	Acid....	Ammonium, Lime, Potassium, Hydrochloric and Carbonic Acids.	In deep grass.
10	Swamp	7	4	Clear...	4...	1....	Acid....	Ammoninm, Lime, Potassium, Hydrochloric, and Carbonic Acids.	In deep grass.
11	Swamp	7	4	Clear...	5...	1....	Nearly.. neutral.	Ammonium, Lime, Potassium, Sodium, Hydrochloric, and Carbonic Acids.	Same plant as last.
12	Swamp	14	6	Dirty...	13...	4....	Slightly acid	Ammonium, Lime, Potassium, Sodium, Aluminium, Carbonic, Hydrochloric and Sulphuric Acids.	In grass near woods and dusty road.
13	Swamp	9	5	Dirty...	7...	2....	Acid....	Ammonium, Lime, Potassium, Iron, Aluminium, Sulphuric and Carbonic Acids.	In grass near woods and dusty road.
14	Swamp	10	6	Quite Clear...	4...	1....	Nearly.. neutral.	Ammonium, Potassium, Lime, Sodium, Hydrochloric and Carbonic Acids.	In open swamp near road.
15	Swamp	5	2	Quite... Clear...	2...	1....	Nearly.. neutral	Ammonium, Potassium, Lime, Sodium, Hydrochloric and Carbonic Acids.	Open swamp.
16	Wet...	8	4	Yellow..	6...	3....	Sl ghtly acid	Ammonium, Potassium, Lime, Sodium, Magnesium, Carbonic and Hydrochloric Acids.	Under grass.
17	Swamp	3	1	Clear...	2...	2....	Slightly acid	Ammonium, Potassium, Carbonic Acids.	Open swamp.
18	Dry...	8	5	Yellow..	4...	4....	Slightly acid	Aluminium, Iron, Potassium, Sodium, Ammonium, Silica, Sulphuric, Hydrochloric and Carbonic Acids.	Side of dusty road and in the shade.

19	Dry...	2	1	Clear	4....	2....	Nearly neutral	Ammonium, Aluminium, Potassium, Sulphuric, Hydrochloric and Carbonic Acids.	Side of dusty road and in the shade.
20	Moist	11	5	Yellow	5....	3....	Slightly acid	Ammonium, Potassium, Lime, Iron, Hydrochloric and Carbonic Acids.	In open swamp near iron springs.
21	Moist	13	5	Yellow	7....	3....	Slightly acid	Ammonium, Potassium, Lime, Hydrochloric and Carbonic Acids.	Under trees.
22	Wet	3	1	Clear	2....	2....	Slightly acid	Ammonium, Lime, Carbonic Acid.	Open swamp.
23	Swamp	5	2	Clear	4....	2....	Slightly acid	Ammonium, Lime, Potassium, Sodium, Hydrochloric and Carbonic Acids.	Open swamp.
24	Swamp	7	2	Clear	6....	2....	Slightly acid	Ammonium, Lime, Potassium, Sodium, Hydrochloric and Carbonic Acids.	Open swamp.
25	Swamp	8	3	Clear	5....	1....	Slightly acid	Ammonium, Lime, Potassium, Sodium, Hydrochloric and Carbonic Acids.	Open swamp.

*This has reference to the time since the leaf was in such a condition that rain could easily enter it.

†Number of parts in 1000.

‡It is probable that in each case when ammonium is reported, nitric acid was combined with it (N H 4, N O 3) but there being but a trace it could not readily be found without much concentration.

‖The organic residue when examined with a microscope revealed the fact that it consisted, to a great extent, of pollen, various other vegetable structures, Infusoria, algæ and the like.

The following tables represent analyses made each month to test the condition of the liquid as the season advanced. The ten enumerated in each table were selected from one hundred analyses made from leaves picked the last day of the month. In each set the two extremes are given and the intermediate ones illustrated well the mean numbers of the complete series of one hundred. The amount of residue is expressed in parts per 1000:

MAY.

Number.	Condition of the soil.	Time in dy's since rain had fallen.	Color of Fluid.	Dried residue from evap'rat'n: Organic.	Dried residue from evap'rat'n: Inorganic.	Reaction.	Inorganic Substances.	Remarks.
1	Swamp	15	Yellow	60....	4......		Ammonium, Potassium, Lime, Sodium, Magnesium, Carbonic and Hydrochloric Acids.	In grass and protected.
2	Quite dry	23	Wine..	100....	8......		Ammonium, Potassium, Sodium, Aluminium, Iron, Sulphuric, Carbonic and Hydrochloric Acids.	Very near dusty road.
3	Moist.	5	Dirty..	108....	5......		Same as No. I.	
4	Swamp	7	Dirty..	110....	4......		Same as No. 1.	Near edge of swamp but away from dust of roads.
5	Edg. of Swamp	5	Wine..	130....	6......	ACID.	Ammonium, Potassium, Lime, Sodium, Magnesium, Iron, Hydrochloric and Carbonic Acids.	Near sandy hill-side.
6	Swamp	3	Yellow	68....	3......		Ammonium, Sodium, Potassium, Lime, Hydrochloric and Carbonic Acids.	
7	Swamp	1	Dark..	82....	2......		Same as No. 6.	Protected by deep grass.
8	Edg. of swamp	6	Dark..	110....	4......		Ammonium, Potassium Lime, Magnesium, Aluminium Sulphuric, Hydrochloric, Carbonic Acids.	Near dry hill-side.
9	Dry...	6	Dirty..	105....	7.....		Same as No. 2.	Barren hill-side, clay soil.
10	Moist.	11	Wine..	115....	4......		Same as No. 6.	Near dry, grassy hill-side and nearly under a willow bush.

JUNE.

Number.	Condition of the soil.	Time in dy's since rain had fallen.	Color of Fluid.	Dried residue from evap'rat'n: Organic.	Dried residue from evap'rat'n: Inorganic.	Reaction.	Inorganic Substances.	Remarks.
1	Swamp	5	Dirty..	120...	7....	ACID.	Ammonium. Potassium, Lime, Sodium Magnesium, Aluminium, Sulp'ric, Hydroch'ric, Carbonic Acids.	Near road.
2	Edg. of Swamp	7	Dirty..	132...	9.....		Same as No. 1, with Iron.	Near road and large iron springs.
3	Moist.	2	Wine..	162...	10.....		Same as No. 2.	Near iron springs.
4	Dry....	3	Dirty .	150...	9.....		Same as No. 3, with Silica.	Near dusty road and sandy hill-side.
5	Dry....	1	Dirty..	142...	6.....		Same as No. 4.	Same.
6	Moist .	4	Dirty..	139...	13.....		Same as No. 5.	Same.
7	Swamp	6	Dirty..	157...	8.....		Same as No. 2.	Near dusty road.
8	Swamp	3	Dirty..	173...	6.....		Same as No. 1.	Near road and under trees.
9	Swamp	6	Dirty..	170...	5.....		Same as No. 2.	In swampy place made by iron springs.
10	Swamp	4	Dirty..	147...	6.....		Same as No. 1.	

JULY.

Number.	Condition of the soil.	Time in d'ys since rain had fallen.	Color of Fluid.	Dr'd res'du from evaporation. Organic.	Inorganic	Reaction.	Inorganic Substances.	Remarks.
1	Swamp	3		137	6		Ammonium, Potassium. Sodium, Lime, Magnesium, Hydrochloric and Carbonic Acids.	Remote from road but near barren spot.
2	Swamp	5		173	8		Same as No. 1, with Iron,	Similar place, but in swamp formed by iron springs.
3	Edg of swamp	11		195	12		Ammonium Potassium, Sodium. Lime. Magnesium. Iron, Silica. Alu'in'm, Hyd'ch'rc, Sulp'rc, Car'bc acids	Very near dusty road and sandy hill-side.
4	Swamp	15		200	7		Same as No. 3, without Iron.	
5	Dry. ..	11		195	11		Same as No. 3.	Same as No 3,
6	Swamp	15	Dirty.	203	6	Acid.	Same as No. 1 with Silica.	In deep swamp, but where the sand could be blown in from a barren spot.
7	Edg. of swamp	15		207	9		Same as No. 2 with Silica.	Similar position to that of No. 6.
8	Swamp	9		187	6		Same as No. 7.	
9	Swamp	8		196	7		Same as No. 3, without Silica.	Near road but in very swampy place.
10	Swamp	9		205	9		Same as No. 3.	In very swampy place. but near very dusty clay road bed and under branches from tree.

AUGUST.

Number.	Condition of the soil.	Time in days since rain had fallen.	Color of Fluid.	Dr'd res'du from evaporation Organic.	Inorganic	Reaction.	INORGANIC SUBSTANCES.	REMARKS.
1	Dry....	10		164	18		Ammonium, Potassium Sodium Lime, Aluminium, Iron, Silica, Carbonic, Sulphuric, Hydrochl'ric Acids.	Near road and near field of sandy soil. Large proportion of silica. Prevailing winds toward the plant from the field.
2	Dry....	5		200	14		Same as No. 1.	A similar location. A large p. c. of silica.
3	Wet...	10		225	10		Same as No. 1.	A similar location but near edge of woods.
4	Wet...	15		205	8		Same as No. 1 without Silica, Aluminium or Sulphuric Acid.	Deep swamp.
5	Swamp	20		237	13		Same as No. 1 without Silica.	Near road and under tall grass and weeds.
6	Dry....	20	DIRTY.	260	16	ACID.	Same as No. 1.	In a damp but not very swampy place surrounded by barren sand-hills. Large proportion of silica.
7	Edg. of swamp	15		257	9		Same as No. 1 without Aluminium, Silica or Sulphuric Acid.	In deep swamp.
8	Moist .	5		245	12		Same as No. 1 without Silica.	Not near road but under trees.
9	Moist .	5		198	10		Same as No. 8.	In a tamarack swamp and under grass which held much dust.
10	Swamp	10		242	9		Same as No. 8.	

The oldest leaves to be found were in each case selected and it is thought that in all cases they were the growth of the season up to date. In preparation the leaf was cut open and the contents removed to a crucible, but in no case was the mass used unless of such a consistency that it would flow easily. The reaction was acid in each case but the degree of acidity increased each month and was very marked through July and August. To just what acid, if any particular one, the reaction was due in the liquid of the earlier pitchers is not certain, but in the two last months both Malic and Citric acids appeared, the former in greater abundance.

The analysis of the ash and the residue of the filtered and evaporated fluid was qualitative. The object being simply to see if there was any relation existing between the inorganic matter contained in the fluid and the surrounding soil, etc., it was not minute. In each case, where it was possible, the soil near by at all liable to get into the pitcher was analyzed. However, not all the inorganic salts could be accounted for as from the soil. Whenever it was evident that the inorganic matter was similar to the soil near the plant it is indicated in the tables under the head "remarks" by giving the character of the surrounding soil.

It seems highly probable that the first lot of insects merely decay after maceration in the water first collected in the pitchers and that this mass acts not only as a stimulant to further decay but also to render the liquid more capable of absorbing certain organic principles from the leaf, such as Malic acid, which aid in the preparation of the abundant supply of food for absorption by the leaf. Thus the first mass might be called a digestive excitant. There being no glands, the process of exciting the leaf to the secretion of an acid would be quite slow.

That this is the case, I feel assured by the fact that absorption evidently takes place much more rapidly during the last days of June and the months of July and August. It is then that much nutriment is needed and the cells are filled with matter. The large tubular cells in the structure of the lower part of the pitcher walls and in fact those extended downward into the root are at this time charged with matter, while earlier, they are comparatively empty, though much nitrogenous matter has been in the leaves for several weeks.

By a set of experiments it was easily shown that the ammonia contained in the liquid, either having its source in the rain water brought to the plant, in the results of the decomposing remains of the insects, or in the absorption from the atmosphere was readily and quite rapidly absorbed by the leaf.

In these experiments it was assumed that but little would be absorbed by the liquid from the air, during the season of experiment, especially if it was a dry time. Such a time was therefore selected and the leaves so turned and propped that no rain could fall into them. The leaves marked were those that contained but few insect remains. Two in each case were examined from each plant. Great care was used that both should have the same age, amount of liquid and nearly the same amount of remains and especially that they should have as near the same size as possible.

One leaf was marked and treated as above while the fluid of the other was immediately tested for organic ammonia and the amount estimated. At the end of a week the marked leaves were picked, quickly examined and the fluid analyzed for organic ammonia. The fluid showed a decided decrease in each case, from the amount found in the one used in comparison. Though these analyses were perhaps quite far from sure in every detail yet the average difference on

comparison, viz: sixty parts in one hundred, would indicate quite rapid absorption, for such an amount could not possibly be removed in any other way.

Associated with the remains of insects in these pitchers and apparently nearly always able to overcome the obstacles to escape, are a few other insects.

The first of these a moth *Xanthoptera semicrocea*, Gneu. which feeds upon the tissue of the leaves themselves, is not so common in the leaf of the side-saddle flower as in the more southern species.

There is another moth besides this which is more common. Though I have not been able to study it to any extent, yet from a casual observation I feel convinced that it is not the same species as the above though the larvæ of both are very much alike. It is possible that it may be a new variety.

The egg is lain within the tube, generally about the middle of the leaf, and fastened to the smooth surface by a web so that seemingly the egg might not only be secure but that also the larvæ might have a secure scaffolding upon which to stand as soon as hatched when it immediately covers the smooth surface with the same kind of web and is thus able to go wherever it wills. It is often the habit of this insect to close the mouth of the pitcher in the southern forms. In a few cases I found threads stretched across the opening of the hood but it is impossible to close the lips of the northern pitcher plant. "As the larvæ increases in size it frets the leaf within feeding on the parenchyma and leaving only the epidermis." Occasionally these larvæ are found dead in the bottom of the pitcher. They had apparently fallen into the liquid and drowned.

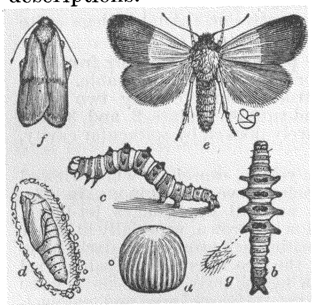
Another very common insect, even more common than the moth, is a fly, *Sarcophaga sarraceniæ*, Riley. A dozen or more living larvæ are dropped into the tube by the fly where they feed upon the decaying mass of insect remains.

As a rule but one larva matures, the others having been devoured by it.

The larva undergoes its metamorphosis in the ground at the base of the leaf. Its transformation is completed in about a week.

Dr. C. V. Riley, U. S. Entomologist, has kindly furnished me with very full descriptions and cuts of the moth, *X semicrocea*, Guen. and the fly *S. sarraceniæ* Riley.

These, with his permission, I append in full * for there are but few printed descriptions.



XANTHOPTERA SEMICROCEA.—*a*, egg, enlarge , the natural size indicated at side; *b c*, larva, back and side views; *d*, chrysalis; *e* moth, normal form, with wings expanded; *f*, pale variety, with wings closed; *g*, enlarged tubercle of larva

XANTHOPTERA SEMICROCEA Guen. Egg—Globular, slightly flattened at top and bottom; 0.02 inch in diameter. Color, when mature, grayish, with about 35 ribs of a paler color, some of them anastomosing and all becoming fainter toward the crown, which is smooth.

Larva—Average length 0.8 inch. Thickest in the middle of the body, and having but three pairs of prolegs. Color deep crimson, or lake-red, the joints being deeply separated, and their borders, especially posteriorly, being white and strongly contrasting with the red. On each of joints 4, 5, 6 and 7 is a pair of more or less confluent, velvety-black, dorsal patches, and a subdorsal, fleshy tubercle, the foremost a little the longest, the others gradually diminishing in length. The other joints are each ornamented with about a dozen small, dark, conical tubercles, transversely arranged on 2 and 3, from a trapezoid to a square on 8, 9, 10 and 11, and on 12 in an opposite position to those on 9: on the cervical shield there are two rows and on the anal plate they are all brought close together. The red parts are more or less thickly beset with short, fuzzy, dark hairs, which are especially dense on the velvety patches and large tubercles mentioned. Venter from joint 8 to anus pale. Head yellowish-white with a deep brown transverse band around the mouth and the forehead, and an irregular spot of the same color on the top and on the front of each lobe. Thoracic legs dark brown; prolegs dusky.

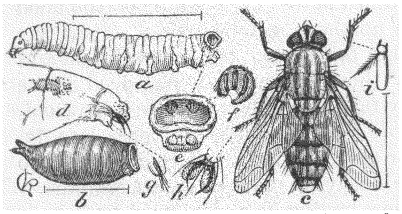
*Descriptions and Natural History of two Insects which brave the dangers of Sarracenia variolaris.—Trans. St. Louis Acad. of Science. By C. V. Riley, Ph. D.

The newly hatched larva is pale, with the dark bands noticeable principally on joints 4–7, the head uniformly pale-brown, and the tubercles scarcely noticeable and surmounted by one or more stiff hairs. In the second stage the tubercles become more prominent, but those on joints 4–7 are not relatively so much larger than the others. In the third stage the characters of the mature larva are assumed, except that the colors do not contrast so greatly, the short hairs are not so dense and the head is often unicolored.

Chrysalis—Uncharacteristic; varying from yellowish-brown to mahogany-brown in color; the head produced into a slight cone in front between the eyes, and the tip of the abdomen armed, in perfect specimens, with two straight converging thorns, and several smaller curled hooks.

Imago—Average expanse 0.8 inch*. Colors, glossy straw-yellow and black. Primaries with the basal half straw-yellow, varying from pale chrome to ochre; the terminal half brown-black with a gray and violet reflection; the two colors sharply separated across the wing at about a right angle from costa. Secondaries same as terminal half of primaries, but usually somewhat paler, especiplly toward base. Under surface uniformly purplish-gray, inclining to yellow basally, and with a somewhat darker median shade usually discernible on primaries. Head black,† with palpi beneath and antennæ yellow. Thorax of the same two colors, sharply separated across the shoulders. Legs yellowish, the tarsi with minute spines, the spurs often with a spinous tip. Abdomen yellowish at base, otherwise concolorous with secondaries.

The species is very variable, the dividing line of the two colors, on primaries, being usually across the middle, but in some specimens much nearer the base of the wing. A striking variety (two specimens) is of a uniform straw-yellow, with the faintest dusky shade across the middle and subterminal portions of primaries; while several have the dark parts more or less suffused with yellow.



SARCOPHAGA SARRACENIÆ —*a*. larva; *b*. pupa; *c*. fly, the hair lines showing average natural lengths; *d*. enlarged head and first joint of larva, showing curved hooks, lower lip (*g*), and prothoracic spiracle: *e*, end of body of same, showing stigmata (*f*) and prolegs and vent; *h*. tarsal claws of fly with projecting pads; *i*, antenna of same. All enlarged

SARCOPHAGA SARRACENIÆ, Riley. Larva—0.30—0.85 inch long. Body composed of but 11 visible joints exclusive of the head; microscopically and transversely shagreened; transversely wrinkled, the hind wrinkle on each joint more particularly prominent laterally. Head extremely small, or ¼ as large as joint 1; showing a division into two maxillary lobes at the tip, and a larger labial lobe, beneath, with a small bunch of setous fibres issuing from it; the black retractile jaws, of the ordinary form, issuing between these lobes, and the antennae showing in two small rufous projections above the maxillary lobes; sparsely armed anteriorly with minute conical, sharp-pointed spines, decurved in front, directed backward beneath. Prothoracic spiracle pale rufous, retractile, sponge-like, studded with numerous lobules, divided at the end into a variable number of branches (6 being usually apparent, never more than 8), which in their turn ramify into lobules. Anal stigmatic cavity quite deep; the fleshy prominences on the carina surrounding it, sub-obsolete; the stigmata but slightly excavated below, the border brown, enclosing three brown openings, the lower ends of which reach to a circular clear space in the corneous and pale rufous peritreme. Anal prolegs quite small, with the longitudinal anal slit between, and a corneous plate in front of them.

Puparium—0.25–0.50 inch long; neither smooth nor highly polished, and varying from yellowish-brown to deep brown-black in color. Insections more or less distinctly traceable. Head and prothoracic joint retracted; the prothoracic spiracles, protruding and forming two small ears, about as long as joint 2; the mass of lobules hardened and rufous. Joints 2 and 3 constricted and flattened; 4 suddenly bulging. End of body squarely docked by spiracular cavity, the rim of which forms quite a ridge.

Imago—Length of body 0.23–0.56 inch. Head pale golden-yellow, especially when viewed from above, with a dark brown or bronze sheen, especially below; eyes ferruginous, in life; duller and bronze-colored in death; stripe between the eyes and all appendages jet-black, though showing, in fresh specimens, shades of brown or yellowish-brown, especially at inner base of antennæ and on maxipalps. Thorax pale ash-gray, with three prominent, dark, longitudinal dorsal vittæ, and two which are shorter, on each side; the two intervening pale dorsal spaces showing also a narrow darker line along their middle: wings slightly fuliginous; tegulæ sordid white; legs black, with the front thighs grayish beneath: cushions large and pale yellowish. Abdomen of the same gray—inclining, in some specimens, to pale golden-yellow, especially behind—checkered with black, the pattern varying with each change of light, but 3 longitudinal lines tolerably distinct from above, the side ones approaching or joining the medial one on the anterior part of each joint, and the whole looking checkered as the light falls on the sides: anus always, and frequently the hind margin of preceding or 4th abdominal joint, pale reddish-brown, the color deepening and becoming less noticeable in the dead specimen; the globular and highly polished male genital organ of a brighter and deeper reddish-brown.

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*The writer finds the extremes of his measurements 0.6 and 1 inch.

†The writer has observed some specimens with brown heads.

REMARKS.—Though there is such great variation in size—depending, no doubt, on the amount of nourishment obtainable by the larva—there is not much in coloration. The species agrees tolerably well with the description of CARNARIA except in having a red anus, and should perhaps be considered only a variety of this last.

The larva differs from Packard's description of that of CARNARIA in the character of the prothoracic spiracle, in lacking the 12 blunt spines around the anal spiracular region, and in having the clear space in the peritreme of the anal spiracles, by which it seems to agree more with his description of Calliphora.

I also find a fly frequenting the pitchers and living upon the remains at the base of the leaf that agrees with the description of *Sarcophaga carnaria* L., or the flesh-fly.

My attention has often been called to the fact that *Musca Cæsar*, L., the blue-bottle fly, is found in the leaves of the Side-saddle flower as well as in some other forms of pitcher plants. (See page 409, Packard's Guide.)

I have often seen specimens of *Musca domestica*, L., the housefly, near the pitchers, but have never seen them inside except when dead. Neither have I been able to raise them from any of the larvæ. It is said, however, that they are known to live in the insect remains.

In answer to the question, "How do these insects succeed in escaping from the pitchers and have apparently perfect freedom in them," Dr. Riley suggests that in the case of the flies it is probably due to the large foot-pads and elongated claws that perhaps reach through the pubescens of the leaf and fasten to the cellular tissue beyond. Their great strength seems also to aid them in escaping by means of a continued buzzing and gradual movement upward. The only fly that seems to escape readily is the Sarcophaga.

The moth has the tarsi covered with long spines which are usually tipped with "a corneous point." The larvæ are perfectly safe in their web-like scaffolding.

Some time was spent in studying all these insects to see if they had any part in aiding the plant in fertilization. None of the insects living in the tube seem to ever frequent the flower. They are either there to feed upon the tissue of the leaf itself or are attracted by the odor of the decomposing mass to feed upon it.

As living insects prey upon the leaf and macerating mass so birds often frequent these leaves to feed upon the living insects. One is often surprised to see the number of ragged holes in the sides of, especially, old leaves. Some of these holes are made by insects in which case shreds of the epidermis still remain.

In several leaves that I knew had been opened by birds I did not find a single living insect. They seem to especially enjoy the fat larvæ of the Sarcophaga fly. It is a well known fact that birds when they obtain a taste of a new food that is especially enjoyable to them seemingly cannot be satisfied till there is no longer a supply. Perhaps this will explain the fact that in some localities the leaves will all be more or less torn while in others the leaves as a whole are without holes.

Though I have not been able to make any extended observation concerning the depredations of birds on the leaves, I have sufficient evidence to show that, in those years when the larvæ of the Sarcophoga fly are especially common, the birds prey to a great extent upon them.